

# Visualizing and Comparing Exploration Plan Alternatives and Change Effects (xPACE), Phase I

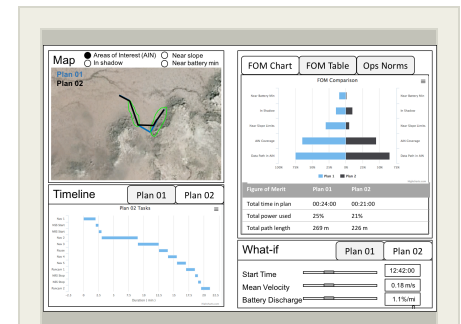
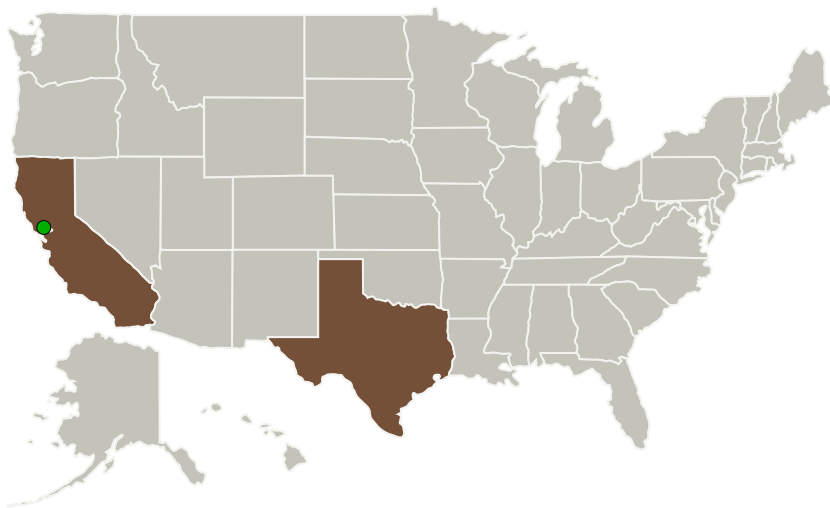
Completed Technology Project (2016 - 2017)



## Project Introduction

Future human space flight missions will take astronauts deeper into space and require increased crew independence from Earth-based flight controllers (crew autonomy). Consequently, they will need to perform more tasks and a greater diversity of tasks. A critical resource for meeting these challenges is greater reliance on robots that can operate with more autonomously [NASA Roadmap TA4]. Greater robot autonomy will require astronauts to manage remote robots operating concurrently with humans. Such management requires the astronaut to plan the activities of one or more robots, direct the execution of the resulting task sequences, and adapt plans when problems or opportunities occur. TRACLabs and CMU propose to develop software for visualizing and comparing exploration plan alternatives and change effects (xPACE) to help crew adapt robot plans quickly and effectively. This software will compute plan figures of merit that provide insight into the effectiveness and risks of plans. It will provide displays using these figures of merit to compare plans from different perspectives and reveal plan strengths and weaknesses. The software also will support modifying plan parameters to improve figures of merit. This software will be designed for evaluation with NASA technology for building robot plans, specifically the IRG Exploration Ground Data System planning software. The proposed software has relevance to more immediate robotic missions operated remotely by humans, such as the Resource Prospector. It is expected that robot plans for tele-operations also will require adaptation during robot operations in response to discoveries or situational challenges. The xPACE software can improve the remote operator's ability to produce safer, more effective plans when re-planning during operations.

## Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
TRAC Labs, Inc.	Lead Organization	Industry	Webster, Texas
● Ames Research Center (ARC)	Supporting Organization	NASA Center	Moffett Field, California
Carnegie Mellon University	Supporting Organization	Academia	Pittsburgh, Pennsylvania
Carnegie Mellon University - Silicon Valley	Supporting Organization	Academia	Moffett Field, California

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

TRAC Labs, Inc.

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

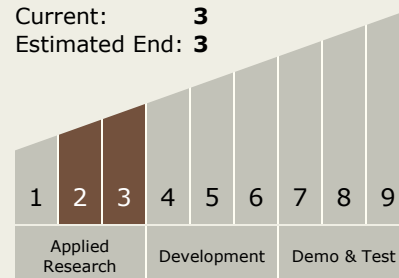
Carlos Torrez

**Principal Investigator:**

Debra L Schreckenghost

## Technology Maturity (TRL)

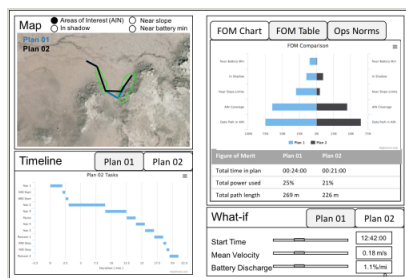
Start: **2**  
 Current: **3**  
 Estimated End: **3**



## Primary U.S. Work Locations

California	Texas
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## Images

**Briefing Chart Image**

Visualizing and Comparing Exploration Plan Alternatives and Change Effects (xPACE), Phase I  
 (<https://techport.nasa.gov/image/127502>)

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## Technology Areas

### Primary:

- TX04 Robotic Systems
  - └ TX04.4 Human-Robot Interaction
    - └ TX04.4.1 Multi-Modal and Proximate Interaction